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(54) **FABRICATING METHOD OF CMOS AND MOS DEVICE**

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(75) Inventors: **Pei-Tu Chou**, Taipei County (TW);
Min-Chieh Yang, Kaohsiung (TW);
Wen-Han Hung, Kaohsiung (TW)

(73) Assignee: **United Microelectronics Corp.**,
Hsinchu (TW)

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H01L 21/8234 (2006.01)

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438/791; 438/792; 438/763; 438/296; 257/E21.293;
257/E21.214; 257/E21.483; 257/E21.487;
257/E21.489; 257/E21.498; 257/E21.626

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438/221, 763; 257/E21.293, E21.214, E21.483,
257/E21.487, E21.489, E21.498, E21.626
See application file for complete search history.

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Primary Examiner—George Fourson

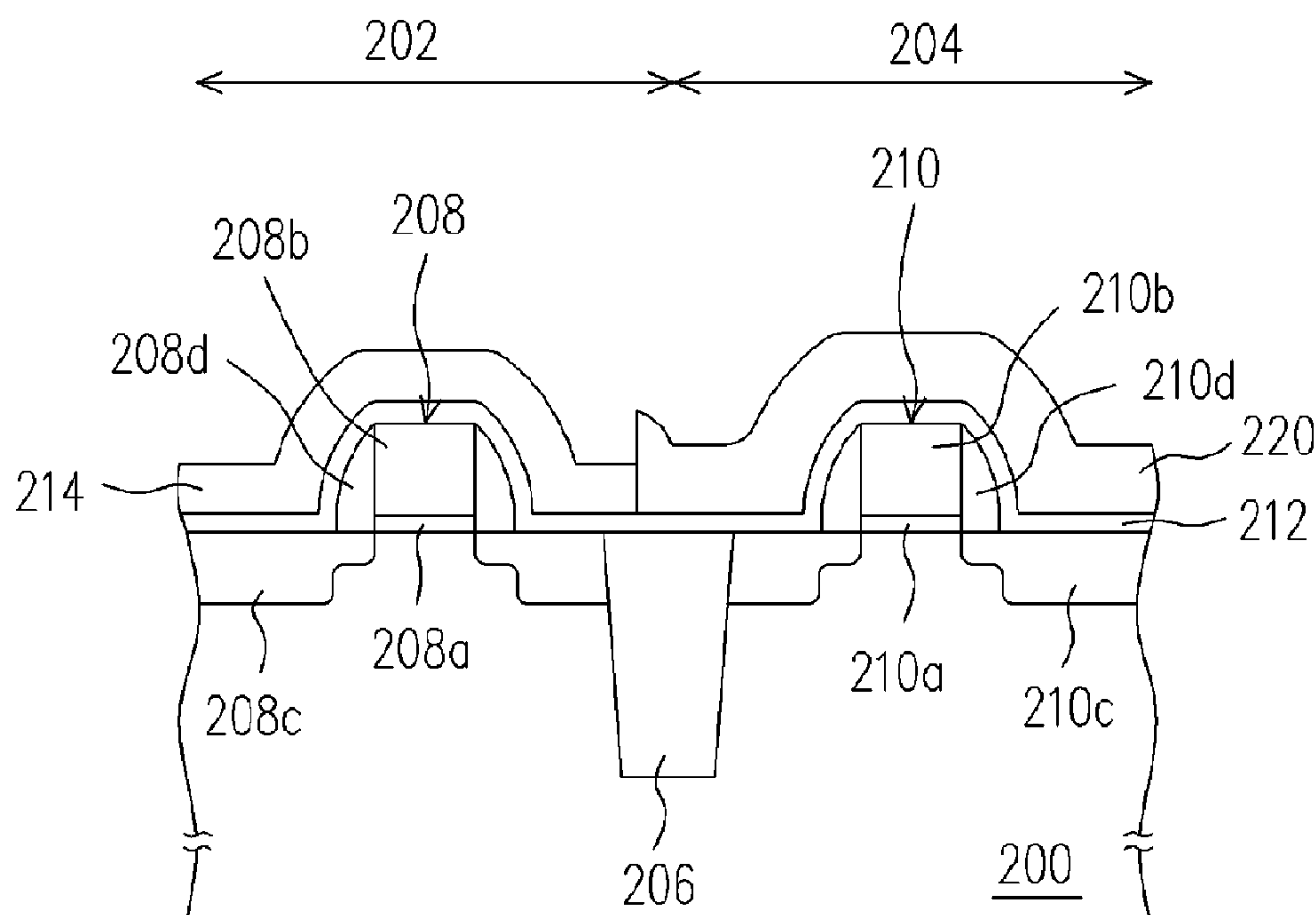
Assistant Examiner—Julio J. Maldonado

(74) *Attorney, Agent, or Firm*—Jianq Chyun IP Office

(57) **ABSTRACT**

A complementary metal-oxide-semiconductor (CMOS) device comprising a substrate, a first type of metal-oxide-semiconductor (MOS) transistor, a second type of MOS transistor, an etching stop layer, a first stress layer and a second stress layer is provided. The substrate has a first and a second active region. The first active region is isolated from the second active region through an isolation structure. The first type of MOS transistor is disposed in the first active region of the substrate and the second type of MOS transistor is disposed in the second active region of the substrate. The etching stop layer covers conformably the first type of MOS transistor, the second type of MOS transistor and the isolation structure. The first stress layer is disposed on the etching stop layer in the first active region and the second stress layer is disposed on the etching stop layer in the second active region.

7 Claims, 5 Drawing Sheets



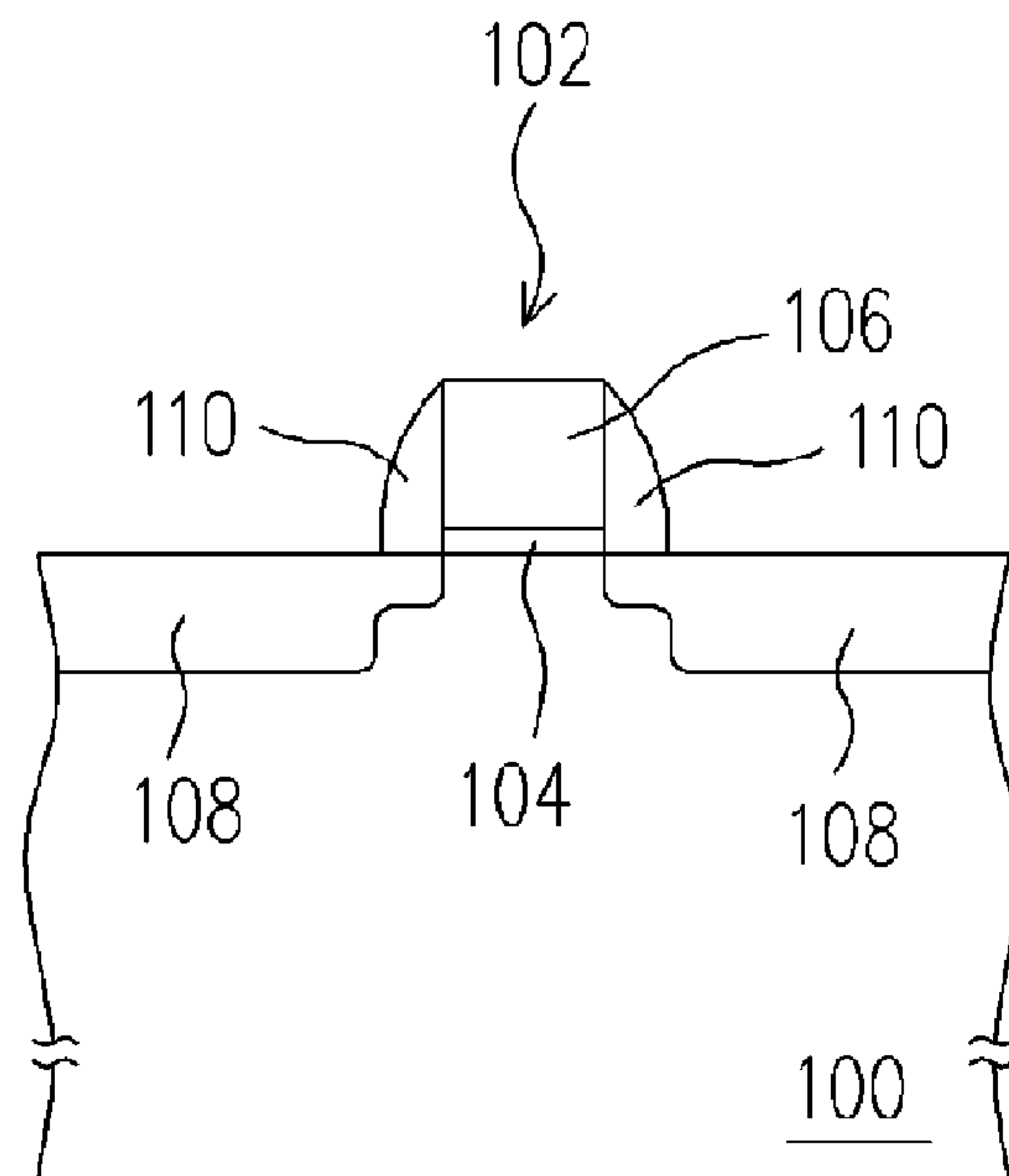


FIG. 1A

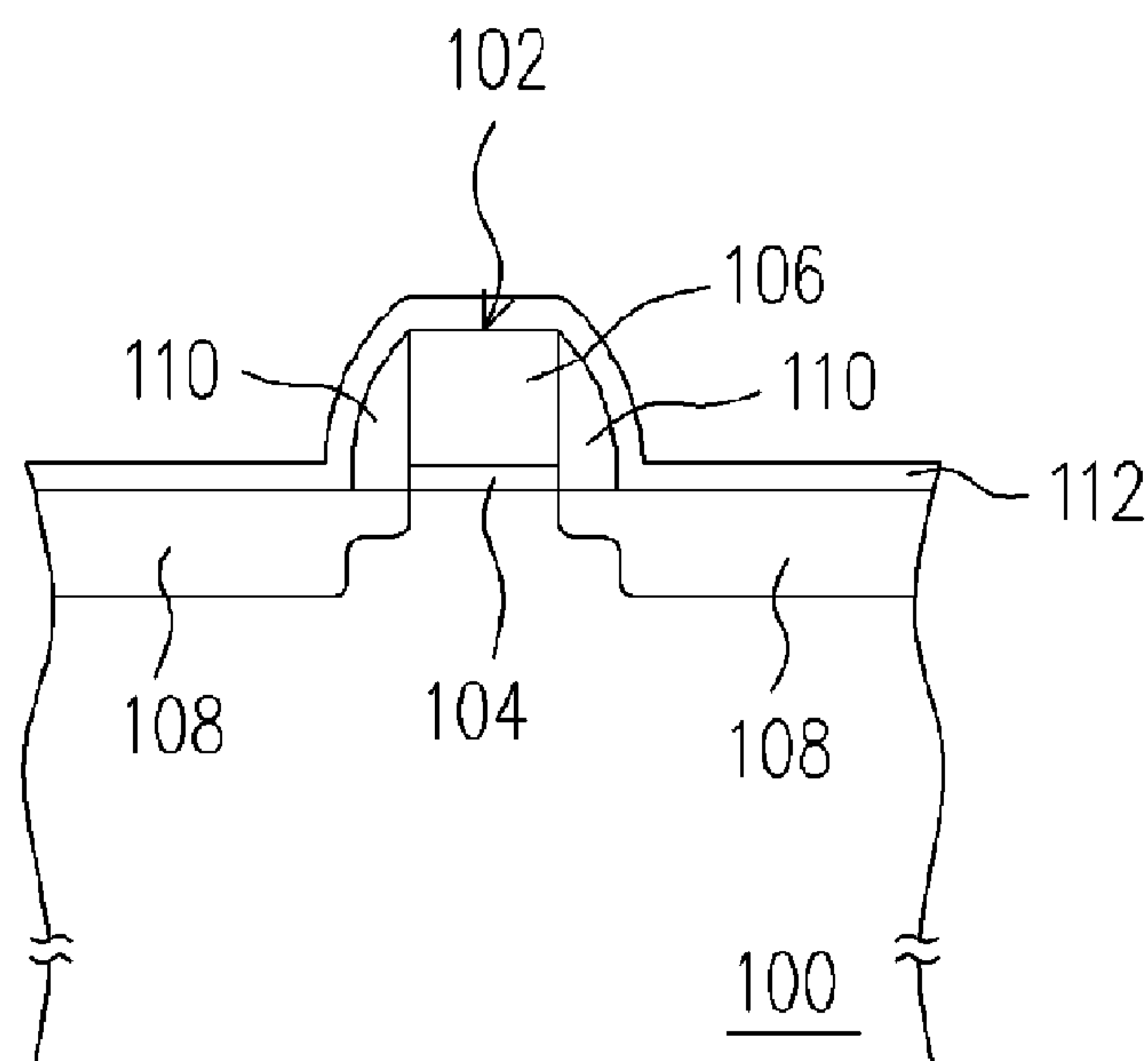


FIG. 1B

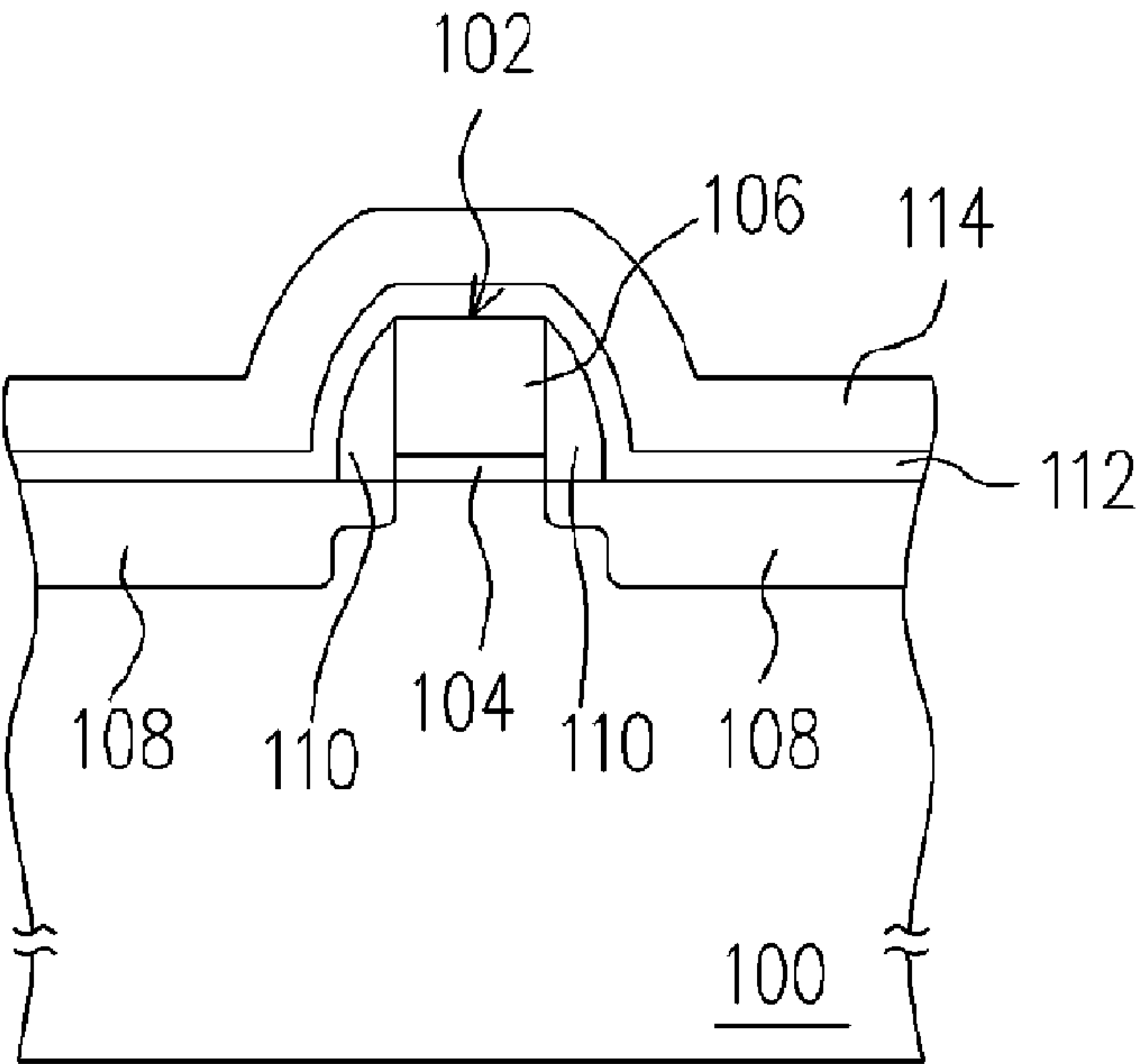


FIG. 1C

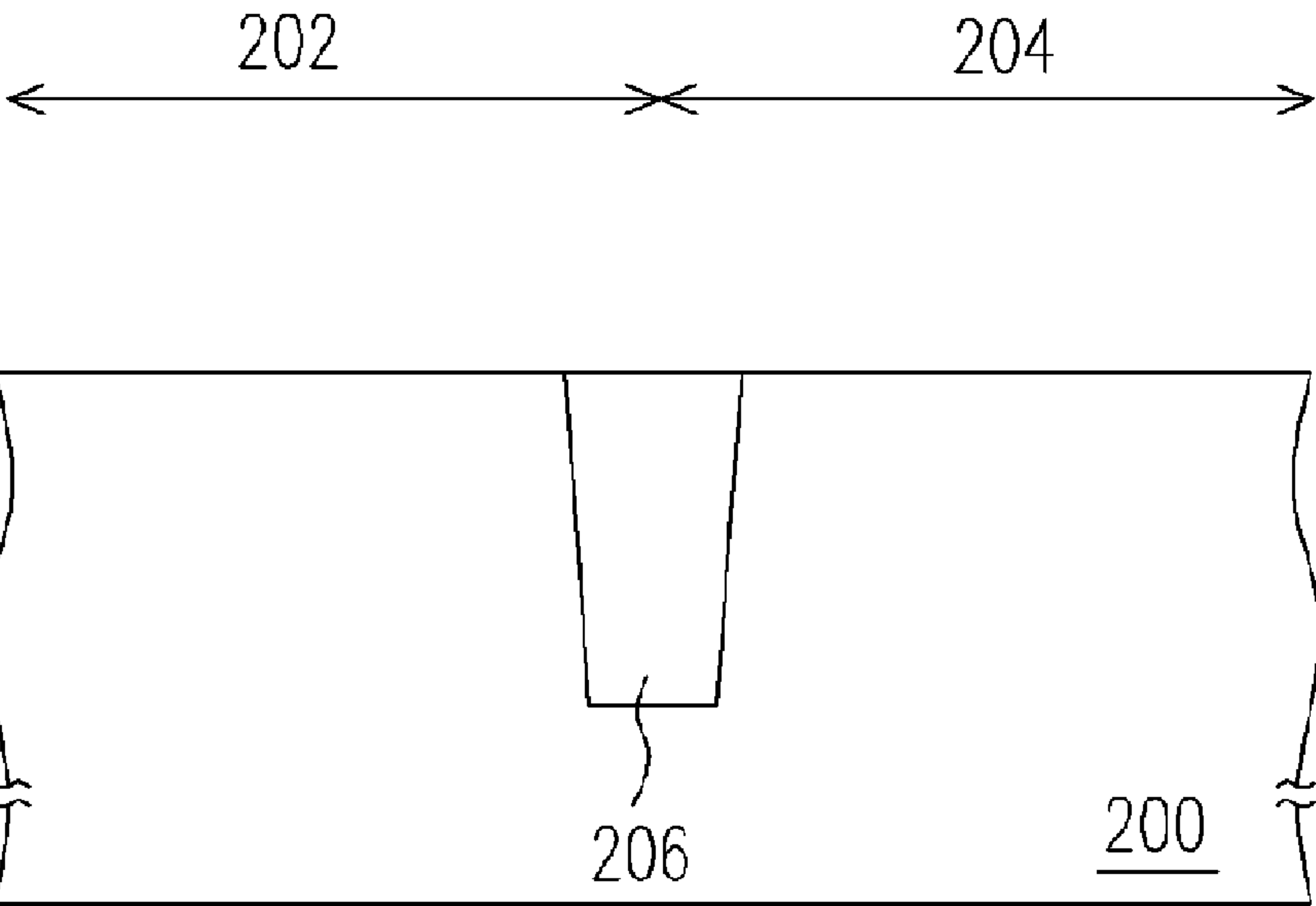


FIG. 2A

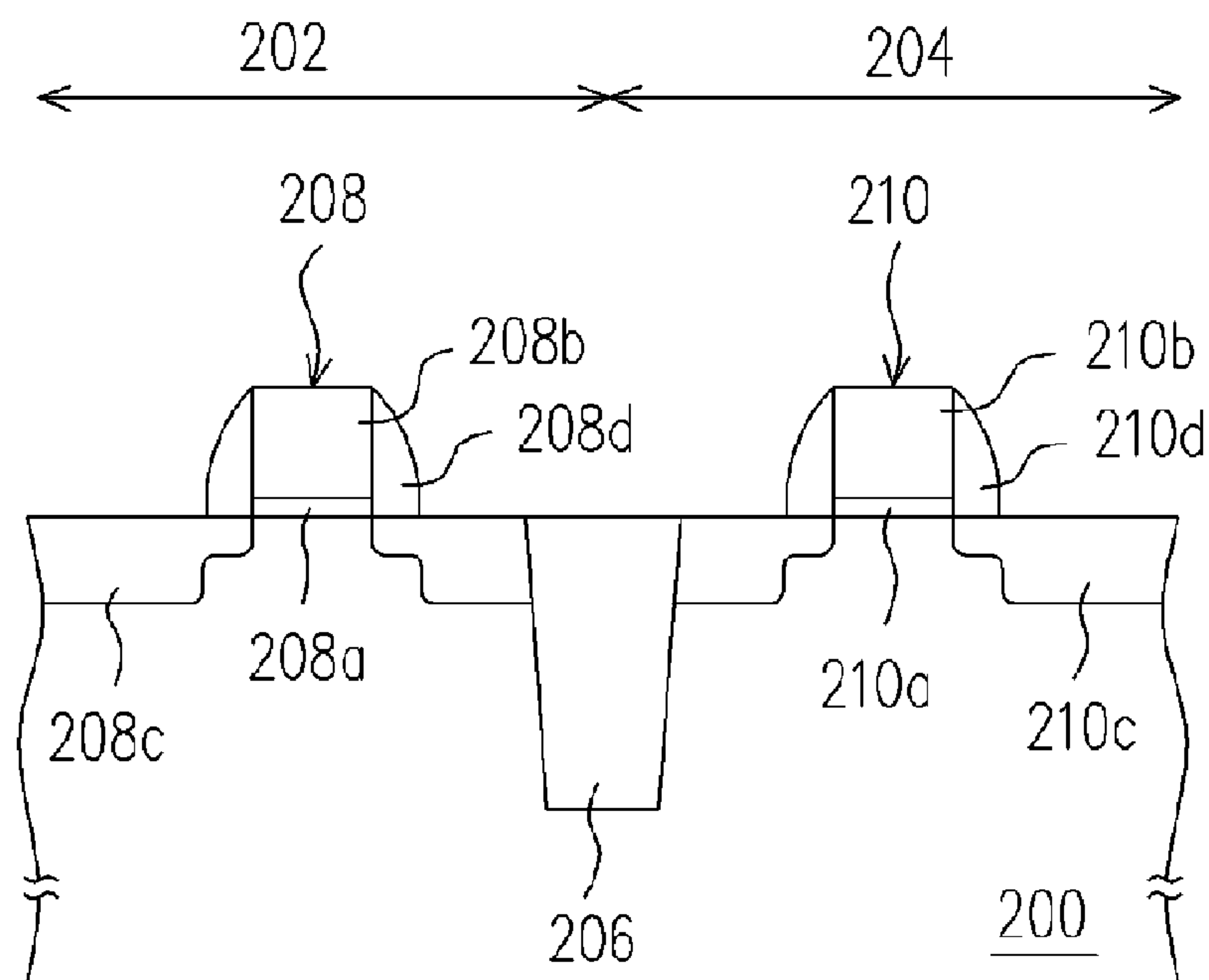


FIG. 2B

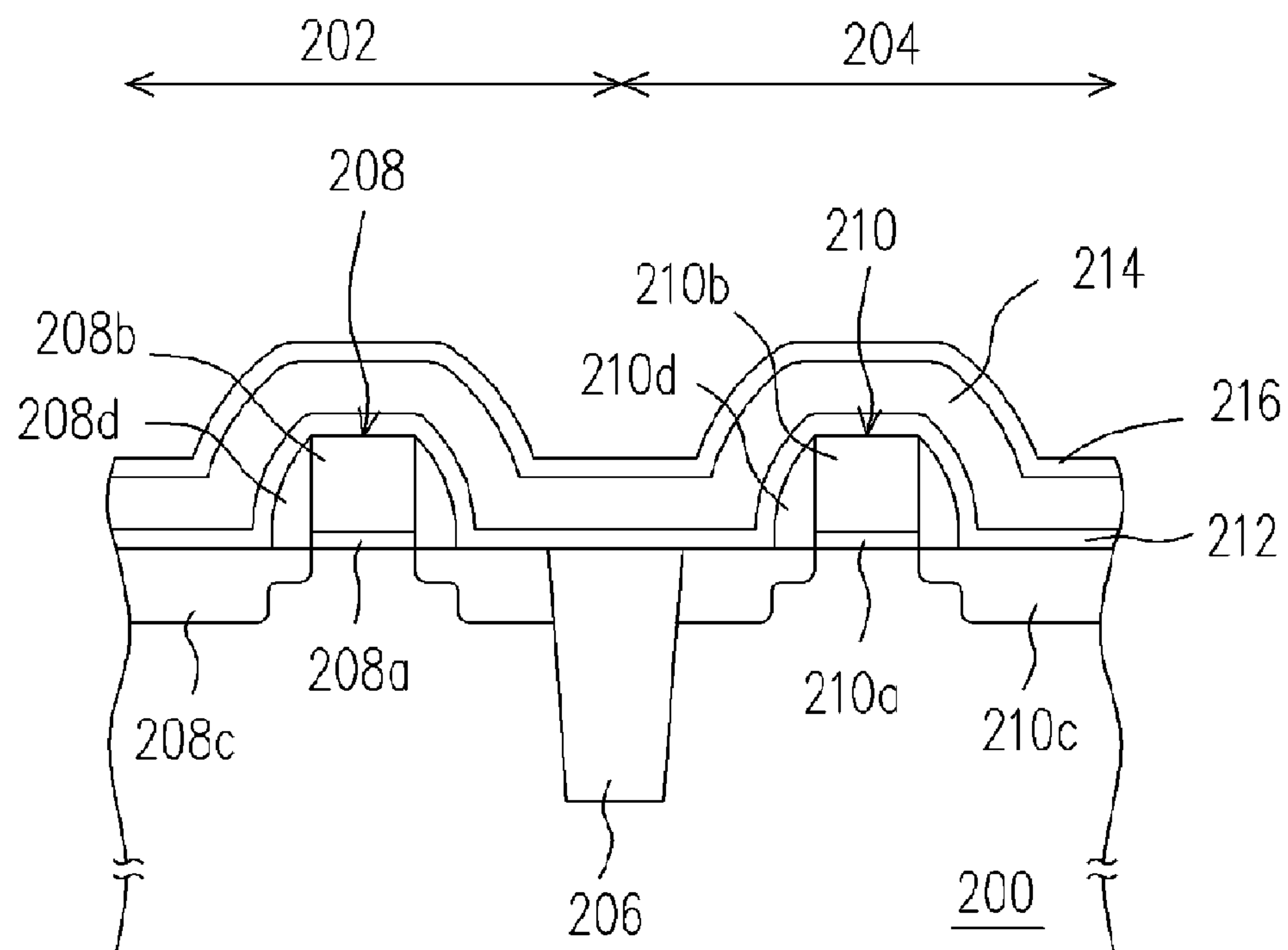


FIG. 2C

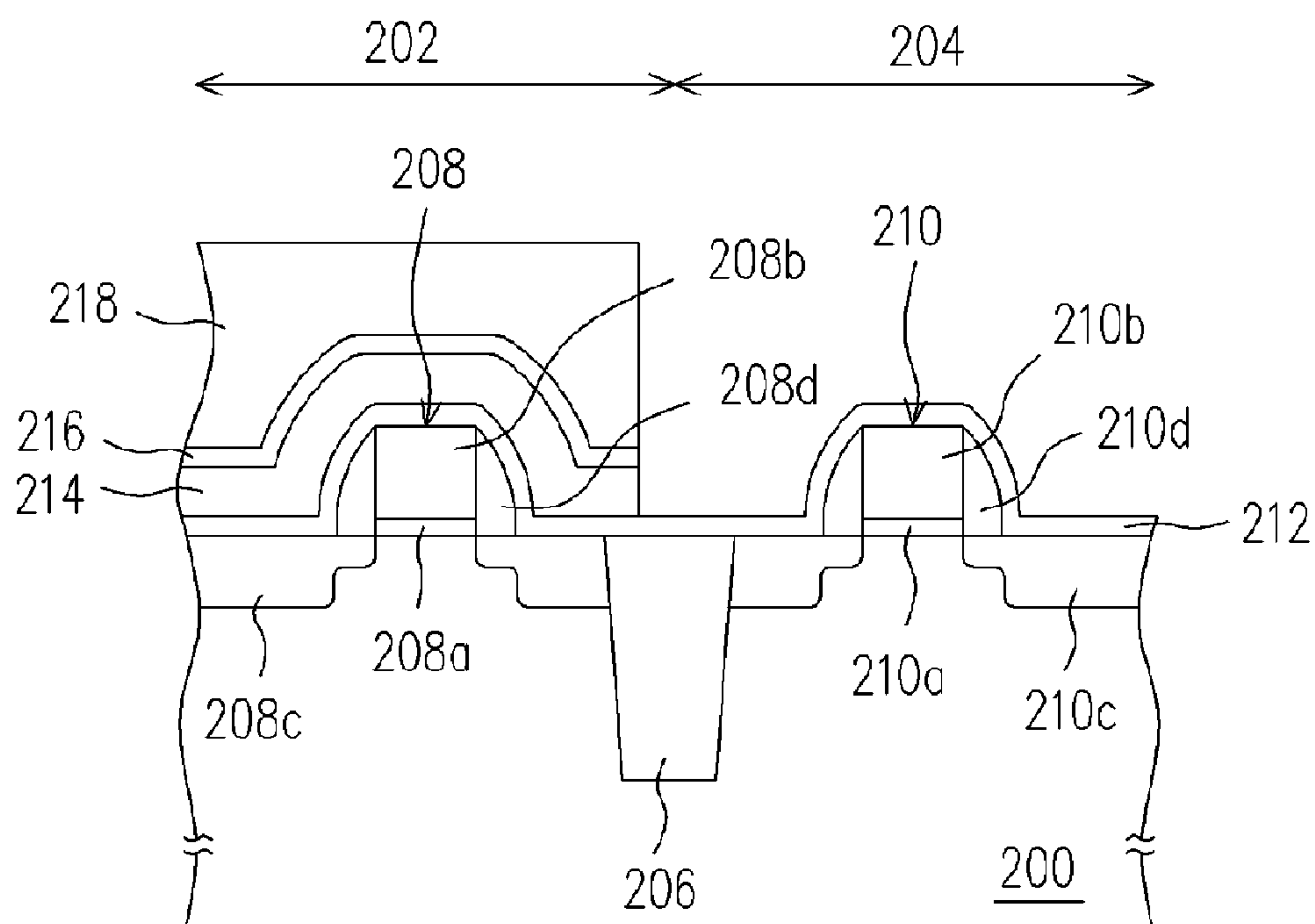


FIG. 2D

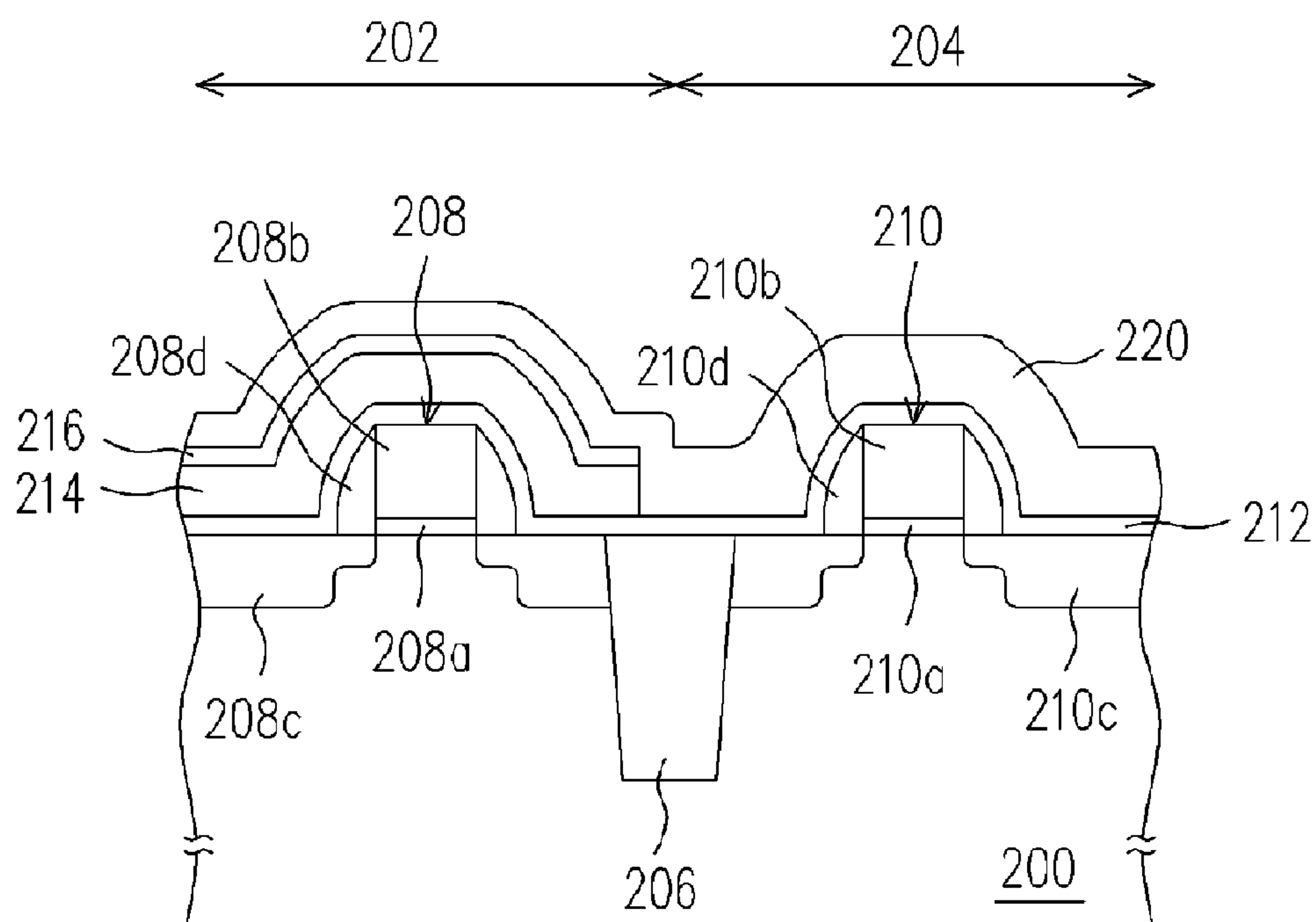


FIG. 2E

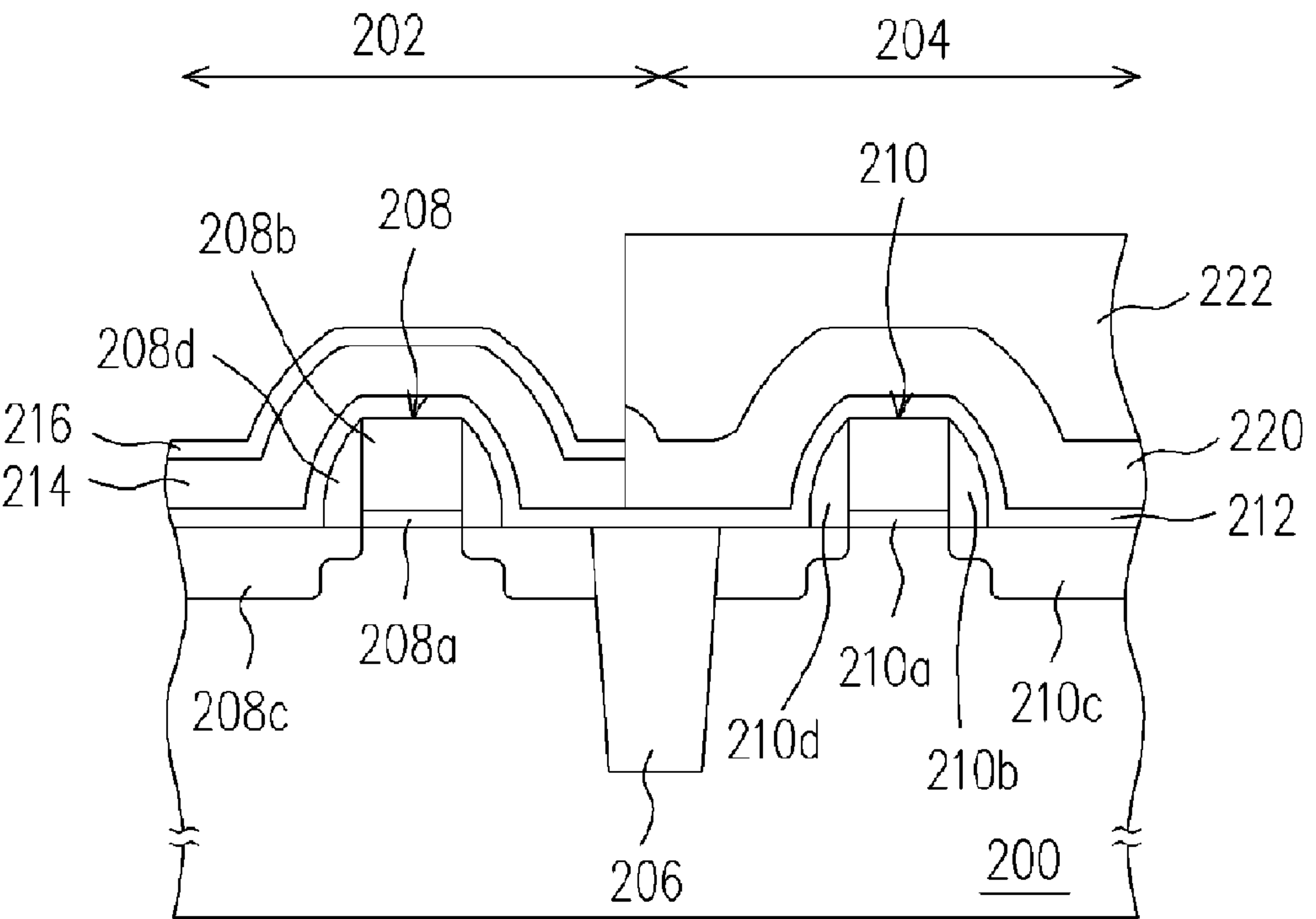


FIG. 2F

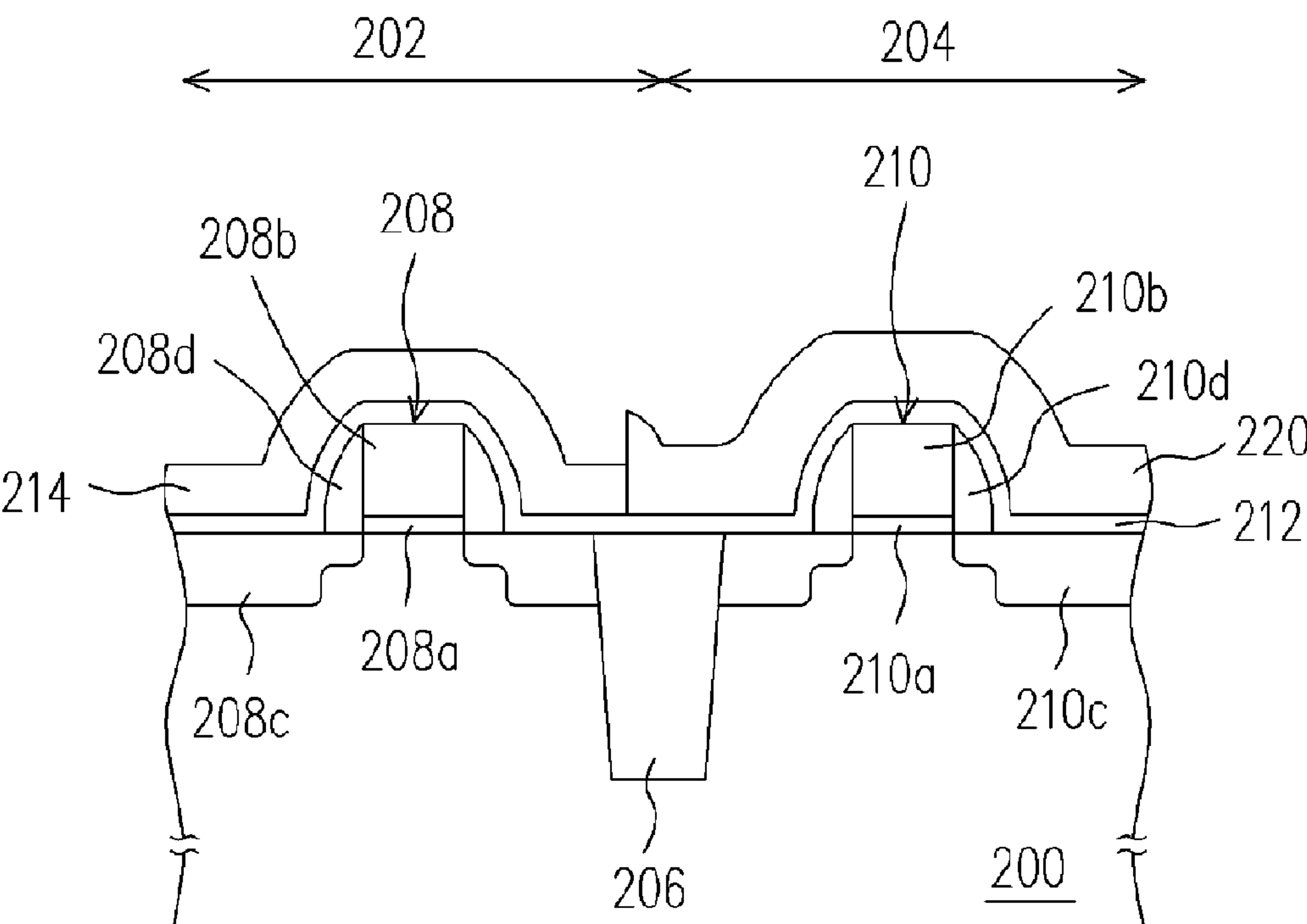


FIG. 2G

FABRICATING METHOD OF CMOS AND MOS DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a semiconductor device and fabricating method thereof. More particularly, the present invention relates to a complementary metal-oxide-semiconductor (CMOS) device and a metal-oxide-semiconductor (MOS) device and their fabricating methods there-
fore.

2. Description of the Related Art

In the development of integrated circuit devices, higher operating speed and a lower power consumption is often achieved by reducing the size of each device. However, further reduction in the dimension of each device is subjected to factors including the bottleneck in the fabricating technique and the expense in the production. Consequently, other types of techniques different from the technique of miniaturizing devices have been developed to improve the driving current of devices. With this background, somebody has proposed the utilization of the stress in the channel region of a transistor to combat the limits in device miniaturization. The method uses stress to change the pitch of silicon crystal grid so that the mobility of electrons and holes is increased and lead to a higher device performance.

One of the conventional method of utilizing stress to increase device performance includes using the stress in a silicon nitride layer that serves as a contact etching stop layer to influence the driving current of the device. Although the driving current in the n-channel region will increase when the tensile stress of the silicon nitride layer is increased, the driving current in the p-channel region will drop. Conversely, although the driving current in the p-channel will increase when the compressive stress of the silicon nitride layer is increased, the driving current of the n-channel region will drop. In other words, the method of using the stress in a silicon nitride layer to improve the performance of the transistor can be used only for increasing the driving current of a N-type metal-oxide-semiconductor (NMOS) transistor or the driving current of a P-type metal-oxide-semiconductor (PMOS) transistor. There is no way to increase the driving current of both the NMOS transistor and the PMOS transistor at the same time.

To increase the driving current of NMOS transistor and PMOS transistor simultaneously, a method for forming a semiconductor device with the following steps is proposed. First, an NMOS transistor and a PMOS transistor are formed on a substrate such that a shallow trench isolation (STI) structure is also formed between the two transistors. Hence, the NMOS transistor and the PMOS transistor are electrically isolated. Thereafter, a silicon nitride layer with tensile stress is deposited to cover up the entire substrate. After that, a patterned photoresist layer is formed over the silicon nitride layer with tensile stress to expose the silicon nitride layer above the PMOS transistor. Using the patterned photoresist layer as a mask, an etching process is performed to remove the exposed silicon nitride layer while retaining the silicon nitride layer on the NMOS transistor. Then, the patterned photoresist layer is removed. Afterwards, using a similar method, another silicon nitride layer with compressive stress is deposited over the entire substrate. Then, the silicon nitride layer above the NMOS transistor is removed while retaining the silicon nitride layer with compressive stress over the PMOS transistor. Consequently, a silicon nitride layer with tensile stress is formed over the NMOS

transistor while another silicon nitride layer with compressive stress is formed over the PMOS transistor. In other words, the driving current of both the NMOS transistor and the PMOS transistor is increased simultaneously.

Although the aforesaid method can increase the driving current of both the NMOS transistor and the PMOS transistor, a few problems that may affect the driving current and performance of the transistors are not tackled. For example, in areas where the pitch between devices is small, the silicon nitride layer at different stress levels may merge together and doubling the thickness of the silicon nitride layer there. Therefore, the silicon nitride layer needs to be over-etched in an etching operation in order to ensure the silicon nitride layer not covered by the photoresist is completely removed. However, this extended etching may damage the film layers and elements such as the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region underneath the silicon nitride layer. Ultimately, there will be some adverse effects on the performance of the device.

SUMMARY OF THE INVENTION

Accordingly, at least one objective of the present invention is to provide a method of forming a complementary metal-oxide-semiconductor (CMOS) device that can prevent possible damages to film layers and increase the performance of the device.

At least another objective of the present invention is to provide a complementary metal-oxide-semiconductor (CMOS) device that can avoid the problem of having damages in the film layers and provide a higher device performance.

At least another objective of the present invention is to provide a method of forming a metal-oxide-semiconductor (MOS) device that can prevent possible damages to film layers and increase the performance of the device.

At least another objective of the present invention is to provide a metal-oxide-semiconductor (MOS) device that can avoid the problem of having damages in the film layers and provide a higher device performance.

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, the invention provides a method of forming a complementary metal-oxide-semiconductor (CMOS) device comprising the following steps. First, a substrate is provided. The substrate has a first active region and a second active region. The first active region is isolated from the second active region through an isolation structure. Then, a first type of metal-oxide-semiconductor (MOS) transistor and a second type of MOS transistor are formed on the first active region and the second active region of the substrate respectively. Thereafter, a first etching stop layer is formed on the substrate to cover conformably the first type of MOS transistor, the second type of MOS transistor and the isolation structure. Then, a first stress layer and a second etching stop layer are formed in sequence over the first etching stop layer. After that, a first photoresist layer is formed on the second etching stop layer in the first active region. Using the first photoresist layer as a mask, a portion of the second etching stop layer and a portion of the first stress layer is removed to expose the first etching stop layer. Thereafter, the first photoresist layer is removed. A second stress layer is formed over the substrate to cover the first etching stop layer and the second etching stop layer. Then, a second photoresist layer is formed on the second stress layer in the second active region. Using the second photoresist layer as

a mask, a portion of the second stress layer is removed to expose the second etching stop layer. Afterwards, the second photoresist layer and the second etching stop layer are removed.

According to the embodiment of the present invention, a curing process may be carried out after forming the first stress layer. And a curing process may be carried out after forming the second stress layer.

According to the embodiment of the present invention, the first etching stop layer is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride and has a thickness between about 50 Å~200 Å, for example. Similarly, the second etching stop layer is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride and has a thickness between about 50 Å~200 Å, for example.

According to the embodiment of the present invention, the first stress layer is fabricated using silicon nitride, for example. Similarly, the second stress layer is fabricated using silicon nitride, for example.

According to the embodiment of the present invention, if the first type of MOS transistor is an N-type metal-oxide-semiconductor (NMOS) transistor and the second type of MOS transistor is a P-type metal-oxide-semiconductor (PMOS) transistor, then the first stress layer is a tensile stress layer and the second stress layer is a compressive stress layer. On the other hand, if the first type of MOS transistor is a P-type metal-oxide-semiconductor (PMOS) transistor and the second type of MOS transistor is an N-type metal-oxide-semiconductor (NMOS) transistor, then the first stress layer is a compressive stress layer and the second stress layer is a tensile stress layer.

The present invention also provides a complementary metal-oxide-semiconductor (CMOS) device. The CMOS device comprises a substrate, a first type of metal-oxide-semiconductor (MOS) device, a second type of MOS device, an etching stop layer, a first stress layer and a second stress layer. The substrate has a first active region and a second active region. The first active region and the second active region are isolated from each other through an isolation structure. The first type of MOS transistor is disposed in the first active region of the substrate and the second type of MOS transistor is disposed in the second active region of the substrate. The etching stop layer is covered conformably the first type of MOS transistor, the second type of MOS transistor and the isolation structure. The first stress layer is disposed above the etching stop layer in the first active region and the second stress layer is disposed above the etching stop layer in the second active region.

According to the embodiment of the present invention, the etching stop layer is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride and has a thickness between about 50 Å~200 Å, for example.

According to the embodiment of the present invention, the first stress layer is fabricated using silicon nitride, for example. Similarly, the second stress layer is fabricated using silicon nitride, for example.

According to the embodiment of the present invention, if the first type of MOS transistor is an N-type metal-oxide-semiconductor (NMOS) transistor and the second type of MOS transistor is a P-type metal-oxide-semiconductor (PMOS) transistor, then the first stress layer is a tensile stress layer and the second stress layer is a compressive stress layer. On the other hand, if the first type of MOS transistor is a P-type metal-oxide-semiconductor (PMOS) transistor

and the second type of MOS transistor is an N-type metal-oxide-semiconductor (NMOS) transistor, then the first stress layer is a compressive stress layer and the second stress layer is a tensile stress layer.

The present invention also provides a method of forming a metal-oxide-semiconductor (MOS) device. The method includes the following steps. First, a conductive type MOS transistor is formed on a substrate. Then, an etching stop layer is formed over the substrate to cover conformably the conductive type MOS transistor. Thereafter, a stress layer is formed over the etching stop layer.

According to the embodiment of the present invention, a curing process may be carried out after forming the stress layer.

According to the embodiment of the present invention, the etching stop layer is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride and has a thickness between about 50 Å~200 Å, for example.

According to the embodiment of the present invention, the stress layer is fabricated using silicon nitride, for example. Furthermore, if the conductive type MOS transistor is an N-type MOS transistor (NMOS), then the stress layer is a tensile stress layer. On the other hand, if the conductive type MOS transistor is a P-type MOS transistor (PMOS), then the stress layer is a compressive stress layer.

The present invention also provides a metal-oxide-semiconductor (MOS) transistor. The MOS transistor comprises a conductive type MOS transistor, an etching stop layer and a stress layer. The conductive MOS transistor is disposed on a substrate. The etching stop layer is covered conformably the conductive type MOS transistor. Furthermore, the stress layer is disposed on the etching stop layer.

According to the embodiment of the present invention, the etching stop layer is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride and has a thickness between about 50 Å~200 Å, for example.

According to the embodiment of the present invention, the stress layer is fabricated using silicon nitride, for example. Furthermore, if the conductive type MOS transistor is an N-type MOS transistor (NMOS), then the stress layer is a tensile stress layer. On the other hand, if the conductive type MOS transistor is a P-type MOS transistor (PMOS), then the stress layer is a compressive stress layer.

In the present invention, an etching stop layer is formed between the stress layer and the transistor. Hence, the problem of damaging the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region as in a conventional method can be avoided. Furthermore, the presence of the etching stop layer in the present invention will not affect the properties of the stress layer and hence degrade the stress layer.

It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

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FIGS. 1A through 1C are schematic cross-sectional views showing the steps for forming a MOS device according to one embodiment of the present invention.

FIGS. 2A through 2G are schematic cross-sectional views showing the steps for forming a CMOS device according to one embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

FIGS. 1A through 1C are schematic cross-sectional views showing the steps for forming a MOS device according to one embodiment of the present invention. First, referring to FIG. 1A, a conductive type metal-oxide-semiconductor (MOS) transistor **102** is formed on a substrate **100**. In the present embodiment, the conductive type MOS transistor **102** is an N-type MOS transistor, for example. The conductive type MOS transistor **102** comprises a gate dielectric layer **104**, a gate **106**, a pair of source/drain regions **108** and a pair of spacers **110**. In one embodiment, a metal silicide layer (not shown) may also be formed on the gate **106** and the source/drain regions **108** to lower the resistance. The metal silicide layer is fabricated using nickel silicide, tungsten silicide or cobalt silicide, for example. Since the elements of the conductive type MOS transistor **102**, the materials constituting the elements and the method of fabricating the conductive type MOS transistor **102** should be familiar to those knowledgeable in this field, a detailed description is omitted.

Referring to FIG. 1B, an etching stop layer **112** is formed over the substrate **100** to cover conformably the conductive type MOS transistor **102**. The etching stop layer **112** has a thickness smaller than 500 Å, preferably between 50 Å~200 Å. The etching stop layer **112** is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride, for example. The etching stop layer **112** is formed, for example, by performing a chemical vapor deposition process or other suitable process.

Referring to FIG. 1C, a stress layer **114** is formed over the etching stop layer **112**. The stress layer **114** is a silicon nitride layer having a thickness between 600 Å~1500 Å, for example. Because the conductive type MOS transistor **102** in the present embodiment is an NMOS transistor, the stress layer **114** is a tensile stress layer.

In one embodiment, a curing process may be carried out after forming the stress layer **114** for increasing the tensile stress in the stress layer **114**. The aforesaid curing process is an ultraviolet curing process, for example.

Obviously, subsequent processes of forming interconnects can be carried out after forming the stress layer **114**. The interconnect fabrication process includes, for example, forming a dielectric layer (not shown) over the stress layer **114** and forming a contact opening (not shown) in the dielectric layer, the stress layer **114** and the etching stop layer **112**. Thereafter, a conductive layer (not shown) is formed in the contact opening to serve as a contact so that corresponding devices are electrically connected together.

Obviously, the conductive type MOS transistor **102** in the foregoing embodiment is illustrated using a NMOS transistor. In another embodiment, the conductive type MOS transistor **102** can be a PMOS transistor. In that case, the stress layer **114** is a compressive stress layer.

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In the aforementioned embodiment, the formation of a stress layer on the conductive type MOS transistor can affect the driving current of the device and improve the performance of the device. In addition, the etching stop layer between the conductive type MOS transistor and the stress layer can be fabricated using a material having an etching selectivity ratio different from the silicon nitride layer, for example. Hence, the etching stop layer can prevent possible damage to the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region.

In the following, a MOS device fabricated using the aforementioned method is described. Referring to FIG. 1C, a metal-oxide-semiconductor (MOS) device comprising a conductive type MOS transistor **102**, an etching stop layer **112** and a stress layer **114** is provided. The conductive type MOS transistor **102** is disposed on a substrate **100**. The etching stop layer **112** is covered conformably the conductive type MOS transistor **102**. The etching stop layer **112** has a thickness smaller than 500 Å, and preferably between 50 Å~200 Å. The etching stop layer **112** is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride, for example. Furthermore, the stress layer **114** is disposed on the etching stop layer **112** and has a thickness between 600 Å~1500 Å, for example. If the conductive type MOS transistor **102** is an N-type MOS (an NMOS) transistor, then the stress layer **114** is a tensile stress layer. On the other hand, if the conductive type MOS transistor **102** is a P-type MOS (a PMOS) transistor, then the stress layer **114** is a compressive stress layer.

Aside from the aforementioned embodiment, the present invention can also be implemented in another configuration. FIGS. 2A through 2G are schematic cross-sectional views showing the steps for forming a CMOS device according to one embodiment of the present invention. First, referring to FIG. 2A, a substrate **200** is provided. The substrate **200** has a active region **202** and a active region **204**. The active regions **202** and **204** are isolated from each other through an isolation structure **206**. The isolation structure **206** can be a shallow trench isolation (STI) structure or other suitable types of isolation structures, for example.

Referring to FIG. 2B, a first type of MOS transistor **208** and a second type of MOS transistor **210** are formed in the first active region **202** and the second active region **204** of the substrate **200** respectively. In the present embodiment, the first type of MOS transistor **208** and the second type of MOS transistor **210** are NMOS transistor and PMOS transistor respectively. The first type MOS transistor **208** comprises a gate dielectric layer **208a**, a gate **208b**, a pair of source/drain region **208c** and a pair of spacers **208d**. The second type MOS transistor **210** comprises a gate dielectric layer **210a**, a gate **210b**, a pair of source/drain region **210c** and a pair of spacers **210d**. In one embodiment, a metal silicide layer (not shown) can be formed on the gate **208b** and the source/drain regions **208c** and the gate **210b** and the source/drain regions **210c** to lower the resistance there. The metal silicide layer is fabricated using nickel silicide, tungsten silicide or cobalt silicide, for example. Since the various elements and materials constituting the aforementioned first type of MOS transistor **208** and second type of MOS transistor **210** and method of fabricating the same should be familiar to those persons knowledgeable in this technological field, a detailed description is omitted.

Referring to FIG. 2C, an etching stop layer **212** is formed over the substrate **200** to cover conformably the first type of MOS transistor **208**, the second type of MOS transistor **210** and the isolation structure **206**. The etching stop layer **212**

has a thickness, for example, smaller than 500 Å, and preferably between 50 Å~200 Å. The etching stop layer **212** is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride, for example. The etching stop layer **212** is formed, for example, by performing a chemical vapor deposition process or other suitable process.

Thereafter, a stress layer **214** and an etching stop layer **216** are formed in sequence over the etching stop layer **212**. In the present embodiment, the stress layer **214** is fabricated using silicon nitride, for example. The stress layer **214** serves as a tensile stress layer and has a thickness between about 600 Å~1500 Å. In addition, the etching stop layer **216** has a thickness, for example, smaller than 500 Å, and preferably between 50 Å~200 Å. The etching stop layer **216** is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride, for example. The etching stop layer **216** is formed, for example, by performing a chemical vapor deposition process or other suitable process. In one embodiment, a curing process may be carried out after forming the stress layer **214** so that the tensile stress in the stress layer **214** is further increased. The aforesaid curing process can be an ultraviolet curing process, for example.

In the embodiment of the present invention, the etching stop layers **212** and **216** can be fabricated using the same material or different materials. Furthermore, the thickness of the etching stop layers **212** and **216** can be the same or can be different. There are no particular limitations in the present invention.

Referring to FIG. 2D, a photoresist layer **218** is formed on the etching stop layer **216** in the active region **202**. Then, using the photoresist layer **218** as a mask, a portion of the etching stop layer **216** and a portion of the stress layer **214** are removed to expose the etching stop layer **212**. The method of removing the etching stop layer **216** and the stress layer **214** includes performing an etching process, for example.

Referring to FIG. 2E, the photoresist layer **218** is removed. Then, another stress layer **220** is formed over the substrate **200** to cover the etching stop layer **212** and the etching stop layer **216**. In the present embodiment, the stress layer **220** is a silicon nitride layer, for example. The stress layer **220** is a compressive stress layer having a thickness between about 600 Å~1500 Å, for example.

Referring to FIG. 2F, a photoresist layer **222** is formed on the stress layer **220** in the active region **204**. Then, using the photoresist layer **222** as a mask, a portion of the stress layer **220** is removed to expose the etching stop layer **216**. The method of removing the stress layer **216** includes performing an etching operation, for example. In one embodiment, a curing process may be carried out after forming the stress layer **220**. The aforesaid curing process can be an ultraviolet curing process, for example.

Referring to FIG. 2G, the photoresist layer **222** is removed. Then, the etching stop layer **216** is removed. The method of removing the etching stop layer **216** includes performing a wet cleaning process, for example.

Obviously, subsequent processes for forming interconnects can be performed after forming the stress layers **214** and **220**. In the process of fabricating interconnects, a dielectric layer (not shown) is formed over the substrate **200** to cover the stress layers **214** and **220**. Then, a contact opening (not shown) is formed in the dielectric layer, the stress layers **214** and **220**, and the etching stop layer **212**. Thereafter, a conductive layer (not shown) is formed inside

the contact opening to serve as a contact for electrically connecting corresponding devices together.

In one embodiment, after removing the photoresist layer **222**, the step of removing the etching stop layer **216** can't be performed and subsequent processes for forming interconnects can be performed. In the step of forming a contact opening of interconnects, an etching process is performed simultaneously on the etching stop layer **216** while a dielectric layer covered the stress layers **214** and **220** is etched.

In the following, a complementary metal-oxide-semiconductor (CMOS) device fabricated using the aforesaid method is described. As shown in FIG. 2G, the CMOS device comprises a substrate **200**, a first type of MOS transistor **208**, a second type of MOS transistor **210**, an etching stop layer **212**, a first stress layer **214** and a second stress layer **220**. The substrate **200** has a active region **202** and a active region **204**. The first active region **202** and the second active region **204** are isolated from each other through an isolation structure **206**. The first type of MOS transistor **208** is disposed in the first active region **202** of the substrate **200** and the second type of MOS transistor **210** is disposed in the second active region **204** of the substrate **200**. The etching stop layer **212** is covered conformably the first type of MOS transistor **208**, the second type of MOS transistor **210** and the isolation structure **206**. The etching stop layer **212** has a thickness smaller than 500 Å, and preferably between 50 Å~200 Å, for example. The etching stop layer **212** is fabricated using silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride, for example. Furthermore, the stress layer **212** is disposed on the etching stop layer **212** in the first active region **202** and the stress layer **220** is disposed on the etching stop layer **214** in the second active region **204**. The stress layers **214** and **220** are fabricated using silicon nitride, for example. The stress layer **214** is a tensile stress layer while the stress layer **220** is a compressive stress layer. Furthermore, the stress layers **214** and **220** have a thickness between about 600 Å~1500 Å, for example.

In another embodiment, the first type of MOS transistor **208** is a PMOS transistor and the second type of MOS transistor **210** is an NMOS transistor. In this case, the stress layer **214** is a compressive stress layer and the stress layer **220** is a tensile stress layer.

It should be noted that a tensile stress layer is formed on an NMOS transistor and a compressive stress layer is formed on a PMOS transistor to affect the driving current of the device and increase the performance of the CMOS device at the same time. In addition, the etching stop layer in the embodiment can prevent possible damage to the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region so that the reliability of the process is improved.

In particular, the etching stop layer in the embodiment of the present invention protects the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region against possible damage without causing any adverse effect on the stress-related properties of the stress layer. The effect of the etching stop layer to the stress layer can be determined from a few tests. The results of the tests are listed in Table 1 below.

TABLE 1

	Ion gain	Ion gain (%)
Experiment #1	1	0
Experiment #2	1.0968	9.68

TABLE 1-continued

	Ion gain	Ion gain (%)
Experiment #3	1.1019	10.19
Experiment #4	1.0968	9.86

In Table 1, four different wafers are tested. In experiment #1, a tensile stress layer is formed on a substrate with devices thereon and an electrical test is performed thereafter. In experiment #2, a curing process is carried out after forming the stress layer and an electrical test is performed thereafter. In experiment #3, an etching stop layer with a thickness of about 100 Å and a tensile stress layer are formed in sequence over a substrate with devices thereon. The substrate is cured and then an electrical test is performed. In experiment #4, an etching stop layer with a thickness of about 150 Å and a tensile stress layer are formed in sequence over a substrate with devices thereon. The substrate is cured and then an electrical test is performed. In all the aforesaid experiments #1~4, the tensile stress layer has a thickness of about 1000 Å.

According to Table 1, the electrical test value, the ion gain, obtained in experiment #1 is used as a reference. The resulting electrical test values (ion gains) in experiment #2~4 are 1.0968 (9.68%), 1.1019 (10.19%) and 1.0968 (9.68%) respectively. The foregoing results show that the electrical test values obtained from the experiment #3, 4 and the experiment #2 are very similar. In other words, the etching stop layer in the present invention has very little effect on the stress-related properties of the tensile stress layer and the degradation of the tensile stress layer is minimal.

Although the tests in Table 1 is performed to determine the effects to a tensile stress layer, the etching stop layer of the present invention similarly will not affect the stress-related properties of a compressive stress layer leading to a degradation of the compressive stress layer.

In summary, major advantages of the present invention includes at least:

1. The stress layer on the MOS transistor can affect the driving current of the device and improve device performance. Additionally, the present invention can increase the performance the NMOS device and the PMOS device at the same time.

2. The etching stop layer can avoid the problem of having any damage to the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region.

3. The etching stop layer formed between the MOS transistor and the stress layer in the present invention is able to protect the spacers and silicone dioxide layer and nickel-silicide of STI structure in the no-transistor region against possible damage without causing change in stress-related properties such as releasing the stress in the stress layer. In other words, the degradation of the stress layer is minimal.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A method of forming a complementary metal-oxide-semiconductor (CMOS) device, comprising:

providing a substrate having a first active region and a second active region, wherein the first active region and the second active region are isolated from each other through an isolation structure;

forming a first type of metal-oxide-semiconductor (MOS) transistor and a second type of MOS transistor on the first active region and the second active region of the substrate respectively;

forming a first etching stop layer over the substrate to cover conformably the first type of MOS transistor, the second type of MOS transistor and the isolation structure;

forming a first stress layer over the first etching stop layer; performing a first curing process to the first stress layer;

forming a second etching stop layer over the first stress layer;

forming a first photoresist layer over the second etching stop layer in the first active region after the first curing process;

removing a portion of the second etching stop layer and a portion of the first stress layer using the first photoresist layer as a mask to expose the first etching stop layer;

removing the first photoresist layer;

forming a second stress layer over the substrate to cover the first etching stop layer and the second etching stop layer;

performing a second curing process to the second stress layer;

forming a second photoresist layer over the second stress layer in the second active region after the second curing process;

removing a portion of the second stress layer using the second photoresist layer as a mask to expose the second etching stop layer; and

removing the second photoresist layer and the second etching stop layer.

2. The method of forming the CMOS device of claim 1, wherein the material constituting the first etching stop layer and the second etching stop layer comprise silicon oxide, silicon oxynitride, silicon carbide, silicon carbonate or silicon-carbon nitride.

3. The method of forming the CMOS device of claim 1, wherein each of the first etching stop layer and the second etching stop layer has a thickness between 50 Å~200 Å.

4. The method of forming the CMOS device of claim 1, wherein the material constituting the first stress layer and the second stress layer comprises silicon nitride.

5. The method of forming the CMOS device of claim 1, wherein the first type of MOS transistor is an N-type MOS (NMOS) transistor and the second type of MOS transistor is a P-type MOS (PMOS) transistor, then the first stress layer is a tensile stress layer and the second stress layer is a compressive stress layer.

6. The method of forming the CMOS device of claim 1, wherein the first type of MOS transistor is a P-type MOS (PMOS) transistor and the second type of MOS transistor is an N-type MOS (NMOS) transistor, then the first stress layer is a compressive stress layer and the second stress layer is a tensile stress layer.

7. The method of forming the CMOS device of claim 1, wherein the first and second curing processes are a UV curing process, respectively.